The formations range in age from Algonkian to Cretaceous, the greater portion being Algonkian, Cambrian and Silurian. The Silurian rocks appear in the Shenandoah Valley, the Cambrian in Catoctin Mountain and Blue Ridge, the Algonkian between these ridges, and the Jaratrias east of Catoctin. The Algonkian rocks are chiefly granite and epidotic schist ; the Cambrian rocks, sandstones and shales, passing up into limestones ; the Silurian rocks, limestones and shales ; and the Juratrias rocks, red sandstone and shale and limestone conglomerate. The details of the strata are shown in the columnar section. The manner in which each kind of rock decays is discussed, and how the residual soils and forms of surface depend on the nature of the underlying rock.

In the discussion of Structure, after a general statement of the broader structural features of the province, three methods are shown in which the rocks have been deformed. Of these the extreme Appalachian folding is the chief; next is that developed in the Juratrias rocks, and least in importance are the broad vertical uplifts. Three degrees of extreme deformation appear in the Paleozoic rocks—folding, faulting and metamorphism—each being best developed in a certain kind of strata. Between Blue Ridge and Catoctin Mountain the Algonkian or oldest rocks appear on a great anticlinal uplift, with Cambrian rocks on either side. Faults appear chiefly on the west side of this uplift, and metamorphism increases toward its east side. In the Shenandoah Valley the rocks are folded to an extreme degree, and the strata are frequently horizontal or overturned. The Juratrias rocks always dip toward the west, and are probably repeated by faults different in nature from the Appalachian faults. In the sheet of sections the details of the folds and faults appear.

Economic products of this region comprise copper and iron ore; ornamental stones, such as marble, limestone conglomerate and amygdaloid; building stones, such as sandstone, limestone and slate; and other materials like lime, cement, brick clay and road materials. The localities of each of these materials are noted and quarries located on the economic sheet, and the character and availability of the deposits are discussed.

AMERICAN FOSSIL BRACHIOPODA.

THE writer has had in preparation since 1886 'A Synopsis of American Fossil Brachiopoda, including Bibliography and Synonymy.' This work, now completed, will appear as one of the Bulletins of the U. S. National Museum and embraces the following chapters: I. Geological Development; II. Brachiopod Terminology; III. Biological Development; IV. Morphology of the Brachia, by Charles E. Beecher; V. Classification; and VI. Index and Bibliography. The following summary, taken from this work, gives some of the more important results obtained, all of which are discussed at length in the work above cited.

In North America there are one thousand eight hundred and forty-six Paleozoic, thirty-seven Mesozoic, and nine Cenozoic species of fossil Brachiopoda. There are one hundred and one species in the Cambrian, three hundred and eleven in the Ordovician, three hundred and twenty in the Silurian, six hundred and fifty-five in the Devonian, and four hundred and eighty-two in the Carboniferous.

This remarkable scarcity of Post-Paleozoic species in America is supposed to be due not so much to the general decline of of the class as to great orographic movements during the close of the Paleozoic, thus producing complete barriers against the introduction of species from other areas. Moreover, few marine sediments are found in them.

Specific differentiation was most rapid in the Ordovician, having exceeded the Cambrian representation more than three times.

Thirty per cent. of all American Paleozoic species had wide geographic distribution, and this is most pronounced in the Devonian and Carboniferous systems. One hundred and twenty-one American species are also found on other continents.

Widely dispersed species are least common in the most primitive order, Atremata, and greatest in the highest orders, Protremata and Telotremata. The difference, however, is but seven per cent.

The order Atremata is represented by one hundred and ninety-six species, or over ten per cent. of the American Paleozoic representation. In the Neotremata it is one hundred and fifty-three, or over eight per cent. The Protremata have seven hundred and thirty-five species, or nearly forty per cent., and the Telotremata seven hundred and sixty-two species, or about forty-one per cent.

The order Atremata is best developed in species and genera in the Cambrian and Ordovician systems; the Neotremata in the Ordovician; the Protremata in the Ordovician, Silurian and Devonian; and the Telotremata in the Devonian. The climax of differentiation is therefore chronologically related to phylogenetic or sequential origin.

Since the four orders of Brachiopoda are present in the Lower Cambrian, ordinal differentiation must have taken place in Pre-Cambrian times. The two more primitive orders, Atremata and Neotremata, have in *Lingula* and *Crania*, respectively, genera with longest life histories. This probably is due not so much to their primitive structures as to their modes of living.

The last order to originate, Telotremata, has the greatest number of generic and superfamily characters and probably also of species.

The last superfamily to appear, *Spiriferacea*, manifests most rapid evolution and is the second one to die out, being preceded by the *Pentameracea*. These two superfamilies are the most highly specialized in the orders to which they belong, and their great specialization may be the cause of their early disappearance.

The trunk families of later origin throughout the class manifest the greatest specific and generic differentiation, the widest specific dispersion, and have species of the largest size and often of longer geologic persistence.

The oldest or most primitive families nearly always have short geologic duration (except *Rhynchonellidæ*), the least generic and specific differentiation, and commonly the individuals are of small size.

The largest of all brachiopods occur in the families *Pentameridæ*, *Productidæ*, and *Spiriferidæ*, at a time when the class was at the height of differentiation.

Large specific size is probably often gradually attained in genetic lines, and is due to favorable food conditions. The gigantic brachiopods always occur in the later developed trunk families, and just before their decline in differentiation.

But eight genera are known to pass from the Paleozoic to the Mesozoic. There are in all three hundred and twenty-one brachiopod genera, two hundred and twenty-three of which are Paleozoic. The Atremata have twenty-six genera; the Neotremata, thirty-one; the Protremata, eighty-seven; and the Telotremata, one hundred and seventy-five.

All brachiopods begin with smooth shells and protegula.

The prodeltidium, or third embryonic shell plate, is known in the Atremata, Neotremata and Protremata. In the Atremata this becomes attached to the dorsal valve, while in the Telotremata it is not apparently developed at all. In the Pro-

tremata it becomes attached to the ventral valve, as in Neotremata. In the two last named orders it modifies the pedicle opening. For this and other ontogentic and morphologic characters Owen's terms Lyopomata and Arthropomata are abandoned. The Atremata and Telotremata are provisionally arranged under the superordinal term *Homocaulia*, and Neotremata and Protremata under *Idiocaulia*.

A true deltidium is present in the *Acrotretacea* of the Neotremata and in the Protremata.

"The cirrated lophophore, or brachia, is alike in the larval stages of all brachiopods. They first develop tentacles in pairs on each side of the median line in front of the mouth (taxolophus stage). New tentacles are continually added at the same points, until by pushing back the older ones there is a complete circle about the mouth (trocholophus stage), later becoming introverted in front (schizolophus stage). From this common and simple structure all the higher types of brachial complication are developed through one of two methods: (1) the growing points of the lophophore, or points at which new tentacles are formed, remain in juxtaposition; or (2) they separate. Complexity in the first is produced (a) by lobation, as in *Magathyris*, *Eudesella*, *Bactrynium*, *Thecidea*, etc. (ptycholophus type), and (b) by looping (zuglolophus) and the growth of a median, unpaired coiled arm (plectolophus), as in *Magellania*, *Terebratulina*, etc.; in the second (c) by the growth of two, separate, coiled extensions or arms, one on each side of the median line (spirolophus), as in *Lingula*, *Crania*, *Discinisca*, *Rynchonella*, *Leptæna*, *Davidsonia*, *Spirifer*, *Athyris*, *Atrypa*, etc." [Charles E. Beecher.]

Morphological equivalents, or similar structural features, are developed independently, as follows: A spondylium in *Obolacea*, *Lingulacea*, *Pentameracea*, and rarely in *Spiriferacea*; crural processes in *Pentameracea* and *Rynchonellacea;* functional articulation in Protremata and Telotremata; straight, more or less long, cardinal areas from rostrate forms in *Rynchonellacea*, *Spiriferacea* and *Terebratulacea*; rostrate shells from long cardinal areas in *Pentameracea*; and loss of pedicle and ventral shell cementation in *Craniacea*, *Strophomenacea* and *Spiriferacea*.

CHARLES SCHUCHERT.

U. S. NATIONAL MUSEUM.

ASTRO-PHOTOGRAPHIC WORK TO BE CARRIED OUT AT COLUMBIA COLLEGE OBSERVATORY.

ONE of the great difficulties that has stood in the way of attaining the highest precision in photographic astrometry has been the determination of a possible distortion of the field of the photographic telescope. Some years ago Dr. Gill tried to meet this difficulty by recommending the possessors of photographic telescopes to make a series of pictures of the group of stars he had used as comparison stars for the planet Victoria in his Solar Parallax work. These stars had been very carefully determined, both in the meridian and with the heliometer, so that a mere comparison of the photographic coördinates with the others ought to throw considerable light on the question of the optical distortion of the photographic telescope. This process has been very carefully carried out by Donner, at the Helsingfors observatory. But the result he has secured leaves the matter still in doubt. His determination of the optical distortion of the Helsingfors telescope by Gill's method does not possess sufficient weight. The cause of this partial failure of Gill's method must be sought in the unfavorable distribution of the Victoria stars for the purpose in question, in the small remaining errors of Gill's star positions, the uncertainty of the proper motions, and perhaps also in the low alti-